

Process for producing 2-bromocyclopentanone

Field of the Invention

The present invention relates to a process for producing
5 2-bromocyclopentanone, which is a useful intermediate for the
production of pharmaceuticals.

Background of the Invention

It is disclosed in the Experimental section of Indian
10 J.Heterocycl.Chem., 1991, 1 (3) 117 that a reaction of bromine
with cyclopentanone in chloroform gave 2-bromocyclopentanone in
a yield of 36%. J. Amer. Chem. Soc., 1985, 107 (25), 7524 discloses
a bromination reaction of cyclopentanone using N-bromosuccinimide
as a brominating agent, and Synthesis 1981, (12) 987 discloses,
15 as a brominating agent, a bromine complex with an
imidazo[1,2-b]pyridine derivative. Zh.Obshch.Khim., 1975,
45(9), 2100 and Chem.Pharm.Bull., 1973, 21(1), 54 disclose
bromination reactions of cyclopentanone enol or enamine with
bromine respectively. Since the yield of the first process is
20 not satisfactory and the latter processes required expensive
brominating agent and derivatization steps to produce
cyclopentanone enol or enamines from cyclopentanone, they are not
always satisfactory for an industrial scale of production.

25 Detailed Description of the Invention

According to the present invention, 2-bromocyclopentanone
can be advantageously produced in an industrial scale of
production.

The present invention provides a process for producing
30 2-bromocyclopentanone which comprises reacting cyclopentanone

with bromine in a biphasic mixture of (i) water and (ii) an organic solvent or mixtures thereof.

2-Bromocyclopentanone is produced, for example, typically by dropwise-addition of bromine to a mixture of a biphasic mixture
5 of water and the organic solvent, and cyclopentanone.

Cyclopentanone is usually used in such an amount that the molar ratios of cyclopentanone to bromine are 20:1 to 1:1, and preferably 10:1 to 1:1, and more preferably 5:1 to 2:1. The amount of water in the biphasic mixture is usually 0.1 to 100
10 parts by weight, preferably 0.5 to 20 parts by weight per one part by weight of bromine.

Examples of the organic solvent, as the component of the biphasic mixture comprising (i) water and (ii) an organic solvent or mixtures thereof, is typically a water immiscible organic
15 solvent. The water immiscible organic solvent means an organic solvent that can form a biphasic mixture with water.

Specific examples of the organic solvent include, for example, halogenated hydrocarbons such as dichloromethane, dichloroethane, chloroform, 1-chlorobutane, or chlorobenzene;
20 ethers such as diethyl ether, a diisopropyl ether, tert-butyl methyl ether or the like;

aromatic hydrocarbons such as toluene, benzene, xylene or the like;

aliphatic hydrocarbons such as hexane, heptane or the like;
25 alcohols such as n-octanol, n-nonyl alcohol, n-decyl alcohol or the like;

esters such as ethyl acetate, butyl acetate, a methyl propionate or the like; and

ketones such as methyl ethyl ketone, methyl isobutyl ketone,
30 or the like. Preferred organic solvent that can form two phases

with water is a water immiscible organic solvent that has no carbonyl group. More preferred are halogenated hydrocarbons, and still more preferred is 1-chlorobutane. The amount the organic solvent or mixtures thereof is usually in a range of from 0.1 to 100 parts by weight, preferably 0.5 to 20 parts by weight per one part by weight of bromine.

The addition of bromine is usually conducted at a range of from -10 to 80°C, preferably about 0 to 50°C. After completion of addition of bromine, the temperature is usually maintained thereafter. For example, after completion of the addition of bromine, the temperature is usually maintained for about 0.5 to 100 hours, preferably for 2 to 50 hours. The temperature after completion of the addition of bromine is usually maintained in the range of from -10 to 80°C, preferably about 0 to 50°C. 2-Bromocyclopentanone thus produced can be isolated by conventional methods. 2-Bromocyclopentanone can be isolated, for example, by separating oil phase and a water phase and evaporating the solvent of the oil phase containing 2-bromocyclopentanone. Unreacted cyclopentanone, if any, may be separated from 2-bromocyclopentanone by distillation. The recovered cyclopentanone can be reused in the present reaction. 2-Cyclopentanone thus obtained may be further purified by distillation, column chromatography or the like.

2-Bromocyclopentanone is, for example, suitably used to produce 2-cyclopentene-1-one by reacting 2-bromocyclopentanone with a base (dehydrobromination reaction). Typical examples of the base include lithium carbonate, which is usually used in the co-presence of lithium bromide. Further specific conditions of the dehydrobromination reaction are referred to, for example, JP2000178220A. Thus produced 2-cyclopentene-1-one may be

purified, if necessary, by distillation, column chromatography and/or the like.

According to the present invention, 2-bromocyclopentanone can be produced from cyclopentanone and bromine with good
5 selectivity.

Examples

The present invention is further illustrated by means of Examples as below but are not to be construed to limit the invention
10 thereto.

Example 1

40.0g (250.3mmol) of bromine was added to a mixture of 63.2g (750.9mmol) of cyclopentanone, 60.0g of water and 60.0g of 1-chlorobutane at 1°C in 2 hours, and the resulting mixture was
15 agitated at the temperature for 15 hours. After the completion of the agitation, 44.0g of water, and 60.0g of 1-chlorobutane were added thereto and agitated at the temperature for 15 minutes, and then the oil phase was separated from the water phase. 185.9g of 1-chlorobutane solution containing 34.5g (211.7mmol, yield:
20 84.7% in terms of bromine) of 2-bromocyclopentanone was obtained as an oil phase. 2-Cyclopentylidenecyclopentanone was not found in this solution.

Example 2

25 40.0g (250.3mmol) of bromine was added dropwise at 1°C to a mixture of 105.3g (1251.5mmol) of cyclopentanone, 60.0 g of water and 60.0 g 1-chlorobutane in 2 hours, and the resulting mixture was agitated at the temperature for 10 hours. After completion of the agitation, 44.0g of water, and 60.0g of 1-chlorobutane was added
30 thereto and agitating at the temperature for 10 minutes, the oil

phase was separated from the water phase. 228.2g of 1-chlorobutane solution containing 33.8g (207.4mmol, yield: 82.8% in terms of bromine) of 2-bromocyclopentanone was obtained as an oil phase. 2-Cyclopentilydenecyclopentanone was not contained in this solution. Evaporation of this solution gave 37.0g of a brownish solution containing 32.8g (201.2mmol, yield: 80.4% in terms of bromine) of 2-bromocyclopentanone. Unreacted cyclopentanone was collected as a distillate.

Example 3

20.0g (125.1 mmol) of bromine was added to a mixture of 31.6g (375.4mmol) of cyclopentanone, 30.0g of water and 30.0g of hexane at 1°C in 2 hours, and the resulting mixture was agitated at the temperature for 76 hours. After the completion of the agitation, 22.0g of water, and 30.0g of hexane were added and agitated at the temperature for 15 minutes, an oil phase-1 was separated from water phase-1. 50.0g of hexane was added to the water phase-1 and agitated at 20°C for 15 min and separated to give an oil phase-2 and a water phase. The oil phase-1 and the oil phase-2 were combined to give 135.6 g of a hexane solution containing 11.5 g (7.03mmol, yield: 56.2% in terms of bromine) of 2-bromocyclopentanone. 2-Cyclopentylidenecyclopentanone was not found in this solution.

Example 4

40.3g (252.2mmol) of bromine was added to a mixture of 42.1g (500.6mmol) of cyclopentanone, 60.0g of water and 60.0g of 1-chlorobutane at 1°C in 2 hours, and the resulting mixture was agitated at the temperature for 24 hours. After completion of the agitation, 44.0g of water and 60.0g of 1-chlorobutane were added thereto and agitated at the temperature for 15 minutes, and the

oil phase and the water phase were separated. 168.6g of 1-chlorobutane solution containing 32.4g (198.5mmol, yield: 78.7% in terms of bromine) of 2-bromocyclopentanone was obtained as the oil phase. 2-Cyclopentylidenecyclopentanone was not found
5 in this solution.

Reference Example 1

40.0 g (250. 3mmol) of bromine was added dropwise to 105.3g (1251. 5mmol) of cyclopentanone at 1°C in 2 hours, and agitated at the
10 temperature for 80 hours. After completion of agitation, 105.3g of water was added thereto and agitating at the temperature for 15 minutes, and separated a water phase to give 83.6g of an oil phase containing 25.2g (154.4mmol, yield: 61.7% in terms of bromine) of 2-bromocyclopentanone and 7.5g (50.0mmol) of
15 byproduct 2-cyclopentilydenecyclopentanone was obtained.

Reference Example 2

40.0 g (250. 3mmol) of bromine was dropwise added at 1°C to a solution of 105.3g (1251. 5mmol) of cyclopentanone in 120.0 g of
20 1-chlorobutane in 2 hours, and agitated at the temperature for 10 hours. After completion of the agitation, 105.3g of water and was added thereto and agitated at the temperature for 15 minutes, and then 226.8g of a solution containing 33.0g (202.3mmol, yield: 80.6% in terms of bromine) of 2-bromocyclopentanone and 7.3g
25 (48.4mmol) of byproduct 2-cyclopentilydenecyclopentanone was obtained.

Example 5

21.6g of a reaction product, which was obtained in a similar manner
30 as in Example 2 and containing 20.0g(122.7mmol) of

2-bromocyclopentanone, was added to a mixture of 60.0g of N,N-dimethylformamide, 5.44g(73.6mmol) of lithium carbonate, 0.51g(4.9mmol) of lithium bromide monohydrate and 0.02g(0.2mmol) of hydroquinone in one hour at 100°C under stirring, and
5 maintained at the same temperature for 3 hours and then cooled to give a solution containing 9.3g (113.0mmol) of 2-cyclopentene-1-one (yield:92.1%). The obtained solution was distilled at 6.7 KPa and 50 to 120°C to give 58.0g of a solution of 9.2g (112.6mmol, yield based on 2-bromocyclopentanone: 91.8%)
10 of 2-cyclopentene-1-one in N,N'-dimethylformamide.